Main drivers of customers and future trends of hay and forage harvesting machinery

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1. Introduction

If you take a closer look at forage harvesting technology and its further development, you will usually start with the analysis of the customers. While in the consumer sector the customer can be addressed and described directly, this is often only possible indirectly in agricultural technology. So the actual customer is the cow or e.g. the fattening bull. In milk production, for example, the description of the customer along the value chain is much more differentiated. This chain of added value starts with feed production as the input variable and is then significantly influenced by the farm, the farmer and, of course, the cow needs. However, it does not end with the farm gate, but goes on to milk processing, distribution, retail and the end customer. All steps along this chain influence the market environment of milk production and are the influencing factors for the purchase decision of harvesting machines. This leads to the requirements for further development of forage harvesting technology.

2. Main Motivation of customers / global dairy farming trends

The main driver for the milk market is the milk price. However, this is the result of the direct relationship between milk production and milk demand. A stable milk price results from a balance between demand and supply. The factors influencing this balance are summarized in **figure 1**. Starting from this simple relationship, we get very quickly to the factors that determine farmers' profitability and influence their willingness to invest. In this way, the relationship between production costs and revenue is derived from the milk price. The production costs are determined by, among other things, feed yield and costs, feed quality, energy costs etc.. Yield and quality are significantly influenced by weather, forage crops, cultivation methods, harvest times and, finally, forage harvesting technology.

Starting from this brief outline of the main motivators, which of course cannot claim to be complete, arrives at the requirements for the forage harvest of the future and influence the essential development trends. Within the framework of the IFCN Conference [1], the current development of the milk market and forecasts of milk demand are worked out and discussed. Despite a considerable increase in milk production in the last 20 years of approx. 3 % per year, the demand will increase by another 35 % by 2030 compared to 2017. This is mainly caused by the population growth, as shown in **Figure 2** [2]. This increase is to be achieved to 1/3 by growth of the herds with simultaneous reduction of the number of farms but to 2/3 by milk yield increase. Furthermore, in addition to growth in the established production locations (e.g. EU and USA), a considerable increase is expected in Asia and China in particular.

3. Hay and forage harvesting machinery

3.1. Process chain of forage harvesting

Along the process chain shown in **Figure 3**, forage harvesting technology can be divided into three main steps: mowing, tedding, swathing and harvesting. Subsequently, further processing takes place. Since different methods have been established for the harvesting step depending on the environment, operating requirements and further processing procedure, the further focus should be on the steps of mowing, tedding and swathing.

- Mowing

  disc mower, drum mower, sickle bar.

- Tedding

  no tedding due to intense conditioner, rotary tedder.

- Swathing

  rotary swather, merger, parallel bar swather, finger wheel rake.

3.2. Trends in hay and forage harvesting machinery

General big trends applicable to agricultural machinery were summarized in [3]. Here the significance of connectivity & digitalization, automation & autonomy and electrification & fuels are explained in more detail.

Based on the above framework conditions and changes in requirements coupled with the availability of technology, general and specific trends can be identified for forage harvesting, which are put into context and explained below.

3.2.1 Harvesting quality

With the targeted increase in performance and yield in milk production, the requirement is an optimal supply of the right feed for the cow. This optimal supply is based on a high feed utilisation and feed quality. A trend towards greater attention and professionalization of dairy farms can be seen here. Awareness of feed quality is increasing or will probably continue to increase.

- Mower

  An increasing demand for forage quality means for the further development of mowers not only a clean cutting pattern but also the optimization of ground hugging. The main control variable is forage contamination. In recent years, various manufacturers have presented and further developed ground hugging systems. One example is the DISCO Move [4] front mower, which has an optimized kinematics for ground hugging with an adjustment range of +600 mm and -400 mm to the zero position.

  A further field of action is the conditioner technology, in order to obtain a gentle but nevertheless sufficient intensive conditioning depending on the crop. Climate changes result in a readiness to change crops. Alfalfa, for example, has different demands on conditioners than ryegrass, so that roller conditioners could probably also become interesting in previous grass

regions.

- Tedder

  Tedders will continue to play an important role in hay production. A growth of the working width can be seen in order to achieve a balanced performance between mower, tedder and swather.

  The combination of mower without conditioner and tedder can also be interesting in some regions to reduce forage contamination and higher flexibility in difficult weather conditions.

- Swather

  In the case of swathers in particular, attention is growing to the issues of rake quality and feed contamination. In [5] a direct comparison from rotary rakes to mergers is carried out. There is a detailed analysis of rake losses and composition including ingredient analysis. The swath shape, which in some cases has considerable effects on the subsequent harvesting processes, will play a major role in future developments.

3.2.2 Autonomous harvesting or automation

In Pichelmeier's presentation, various future trends are shown and various small autonomous units are presented which take over activities on the field in the swarm [3]. For grass harvesting, first approaches towards autonomous harvesting and stronger automation can be seen.

- Mower

  Already in 2014 Kongskilde presented a robot for grass harvesting - Grassbots - Denmark [6]. In the further development of autonomous mowing units, however, the required impact capacity, the usual driving speed and the frequently changing fields (depending on the region) must be taken into account. For safe work, it is necessary to identify obstacles in advance - technologies from the automotive sector can be certainly adapted here. However, the challenge of identifying obstacles in the field will require further research.

  In order to achieve the above-mentioned feed quality and to relieve the driver, steps towards automation will also be recognizable in the future. One example is the automatic slope control on the DISCO 9200 C Autoswather. This takes the slope inclination into account and includes an automatic contact pressure control for the two rear mower units. To reduce slope drift, the mower unit is relieved less downhill and the mower unit is relieved more uphill. This means that, on the one hand, greater friction on the mower unit downhill stabilizes the tractor and, on the other hand, the rear wheel is subjected to greater load as the load is relieved uphill. Both of these factors lead to stabilization. In addition, the conveyor belt speed is automatically adjusted to ensure an even swath shape.

- Swather

  The swather also offers functions such as section control and rake height adjustment to increase comfort.

  In 2015, an electric drive integrated into the swath gearbox was introduced [8]. The electric drive provides various options for detecting load and speed adjustment, among other things.

With the availability of suitable drive technology in terms of price and weight, this trend will certainly continue to gain in importance.

3.2.3 Self mechanization

Figure 4 [9] shows the development of the milk price and the sales figures of mowers. The graph shows that the development of sales figures is similar to that of milk price volatility. This confirms the above-mentioned correlation between price and willingness to invest. Overall, a slight decline in the number of units can be seen. If this development is presented in relation to the development shown in **Figure 5**, two conclusions can be drawn. Firstly - a decreasing number of farms leads to decreasing sales figures - with increasing milk production this means a larger average working width per unit. Secondly, of course, a regional variation in inter-farm use can partly compensate for this decline by higher utilization. A clear trend towards strengthening self-mechanization and size growth must therefore be assessed regionally.

3.2.4 Digitalization / complete process chain

Digitalization and smart farming are trends in agricultural engineering [10], which will also be an increasing driver for innovations in the future of forage harvesting. Starting with the integration in farm management systems for the documentation of operations and results, the use of acquired data for the optimization of processes will become more important.

There is great potential in the linkage of machines and work processes. Thus, the time of harvest and the timing of the work steps have a considerable influence on the forage quality to be achieved. The use of e.g. weather data and machine information and their interaction will offer great opportunities for further development.

4. Conclusion

Overall, forage harvesters are characterised by an extremely high degree of diversity. While on the one hand large professional machines with a high degree of automation are required to increase productivity, for some regions and customers small simple machines are the right solution. For the further development of products, a clear definition of customer requirements and a clear segmentation is therefore necessary, as illustrated in F**igure 6**. Furthermore, the different regions must be taken into account in product development.

Market developments and drivers for customers shape the megatrends in forage harvesting. Different drivers can be easily derived from milk production. Increasing demand for milk leads to higher demands on feed quality and productivity.

Trends for the development of products are derived from this. These requirements are met with a broad product portfolio. These products, however, will always have a high demand on reliability and functional safety. Building on this, a high demand will always be placed on performance and comfort. The use of digitalization will then round off the needs, as can be seen from the adapted maslow's hierachy of needs (**Figure 7**).

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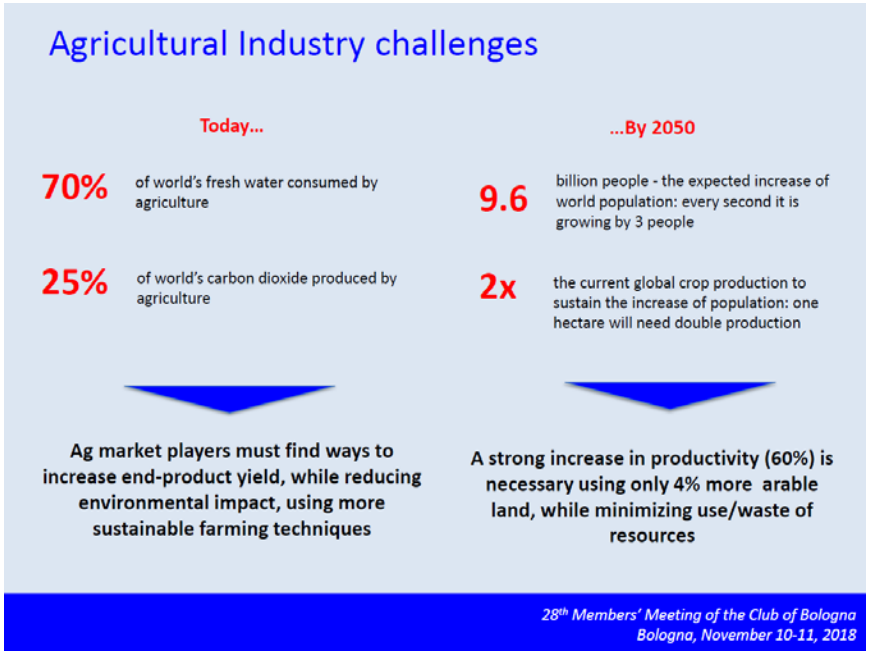
FIGURES

Figure 1 – Drivers of the supply/demand balance 2017 *(Source: [1])*.

Figure 2 – Agricultural Industry challenges *(Source: [2])*.



http://www.clubofbologna.org/ew/ew_proceedings/2018_S1.2_PPTX_PROTANO_VANDECAVEYE.pdf

Figure 3 – Process chain of forage harvesting.

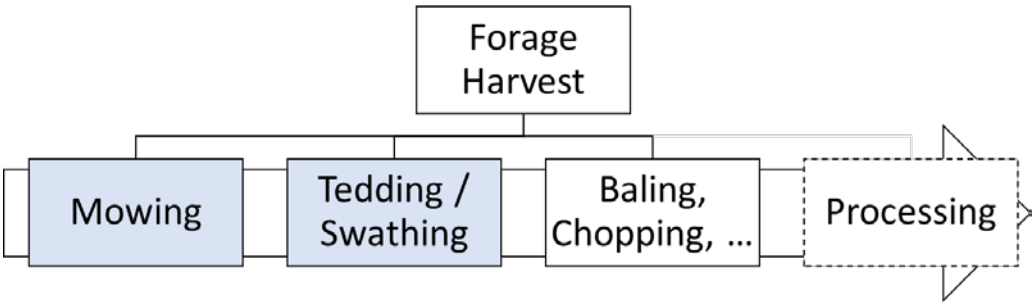


Figure 4 – Milk price and sales numbers of mowers in Germany – 2002 to 2018 *(Source: [2])*.

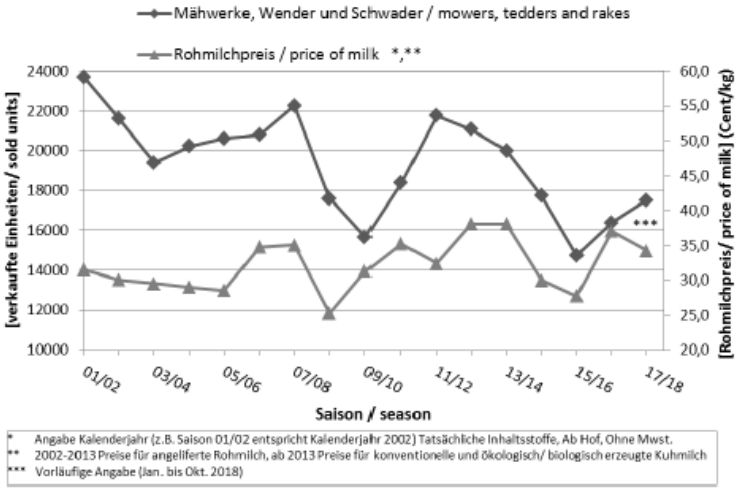


Bild 1: Verkaufszahlen in Deutschland von Mähwerken, Wendern und Schwadern nach VDMA sowie Rohmilchpreis [1–3]

Figure 1: Sales of mowers, tedders and swathers in Germany according to VDMA and price of milk [1–3]

Figure 5 – Development of dairy cows per national size class *(Source: [1])*.

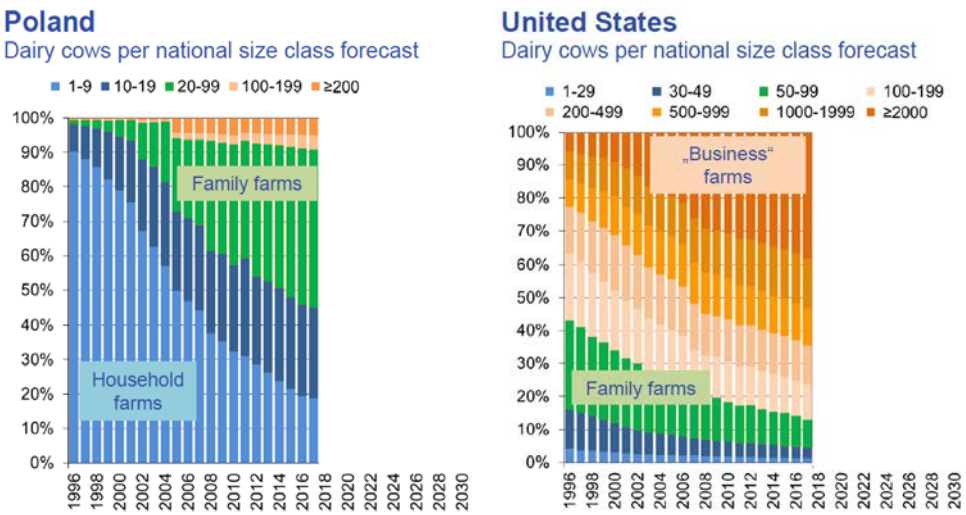


Figure 6 – Basic approach of market segmentation

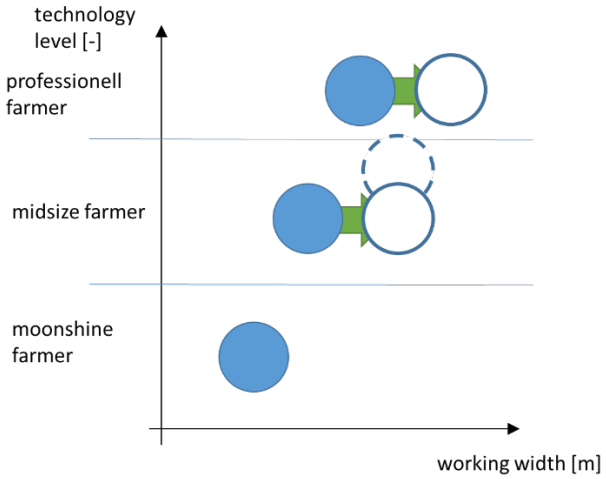


Figure 7 – maslow's hierachy of needs for forage machinery